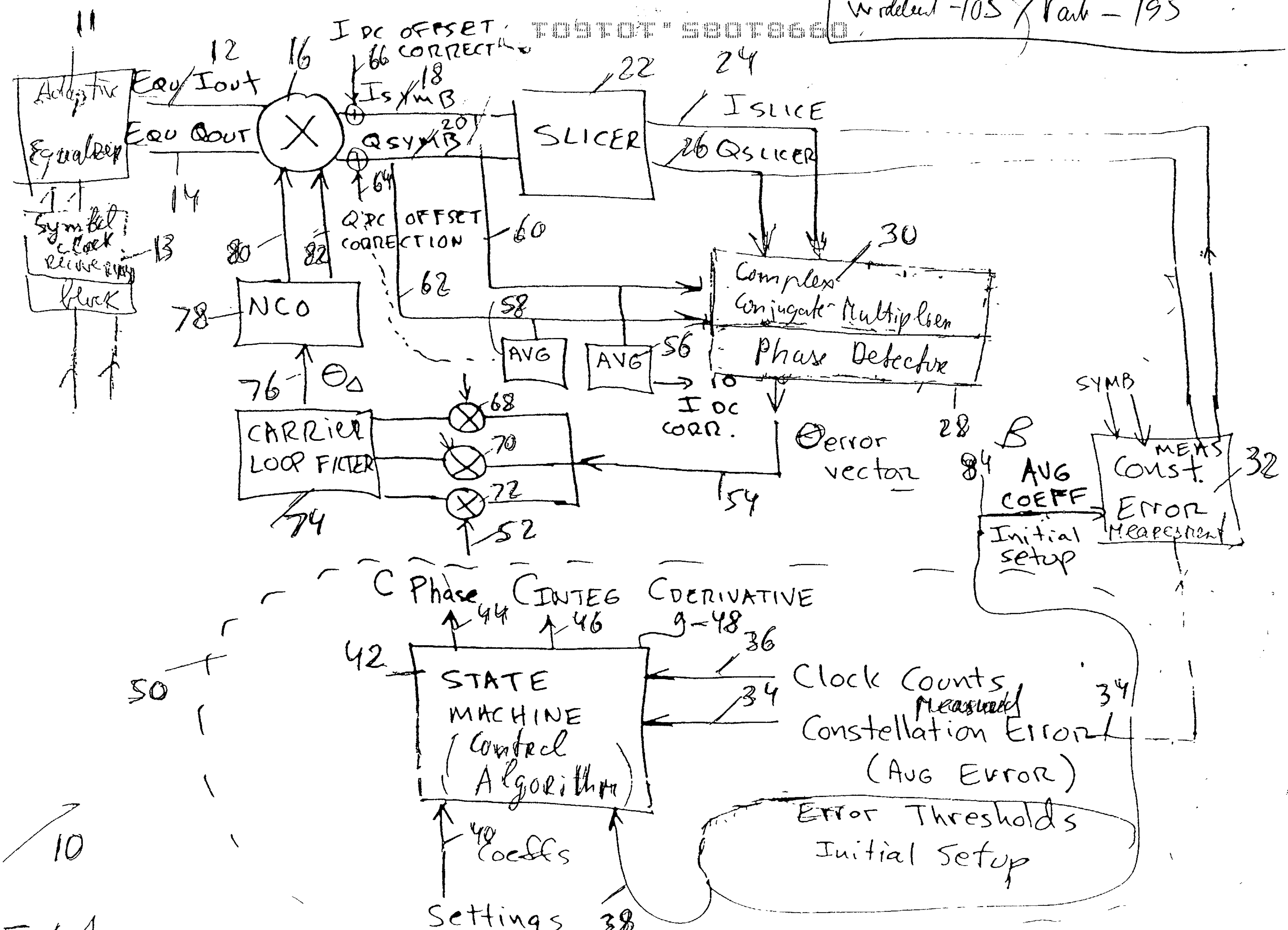
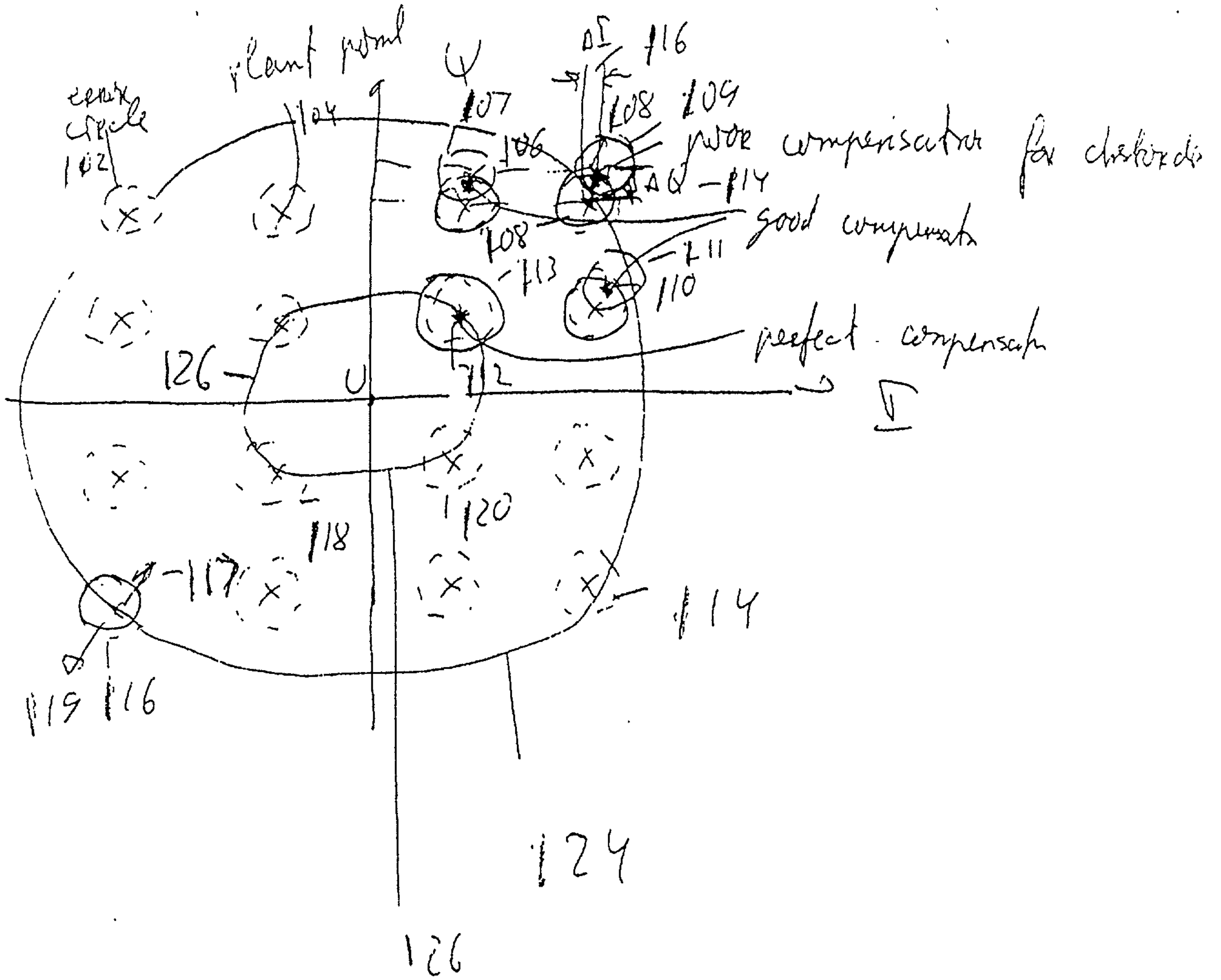

Adaptive Equalizer
Symbol Clock Recovery
Clock
EQU Iout
EQU Qout
I DC OFFSET CORRECTION
ISYMB
QSYMB
Q DC OFFSET CORRECTION
SLICER
ISLICE
QSLICER
Complex Conjugate Multiplier
Phase Detector
I DC CORR.
AVG
AVG
NCO
CARRIER LOOP FILTER
Θerror vector
SYMB
MEAS CONST. Error Measurement
AVG COEFF
Initial setup
C Phase
C INTEG
C DERIVATIVE
STATE MACHINE (Control Algorithm)
Clock Counts
Measured Constellation Error (Avg Error)
Error Thresholds Initial Setup
Coeffs
Settings
11
12
13
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
68
70
72
74
76
78
80
82
84
10

FIG. 1


error circle
102
plant point
104
107
106
108
109
ΔI
116
poor compensation for distortion
ΔQ
114
good compensation
113
111
110
perfect compensation
112
126
I
118
120
117
119
116
114
124
126

100

FIG. 2

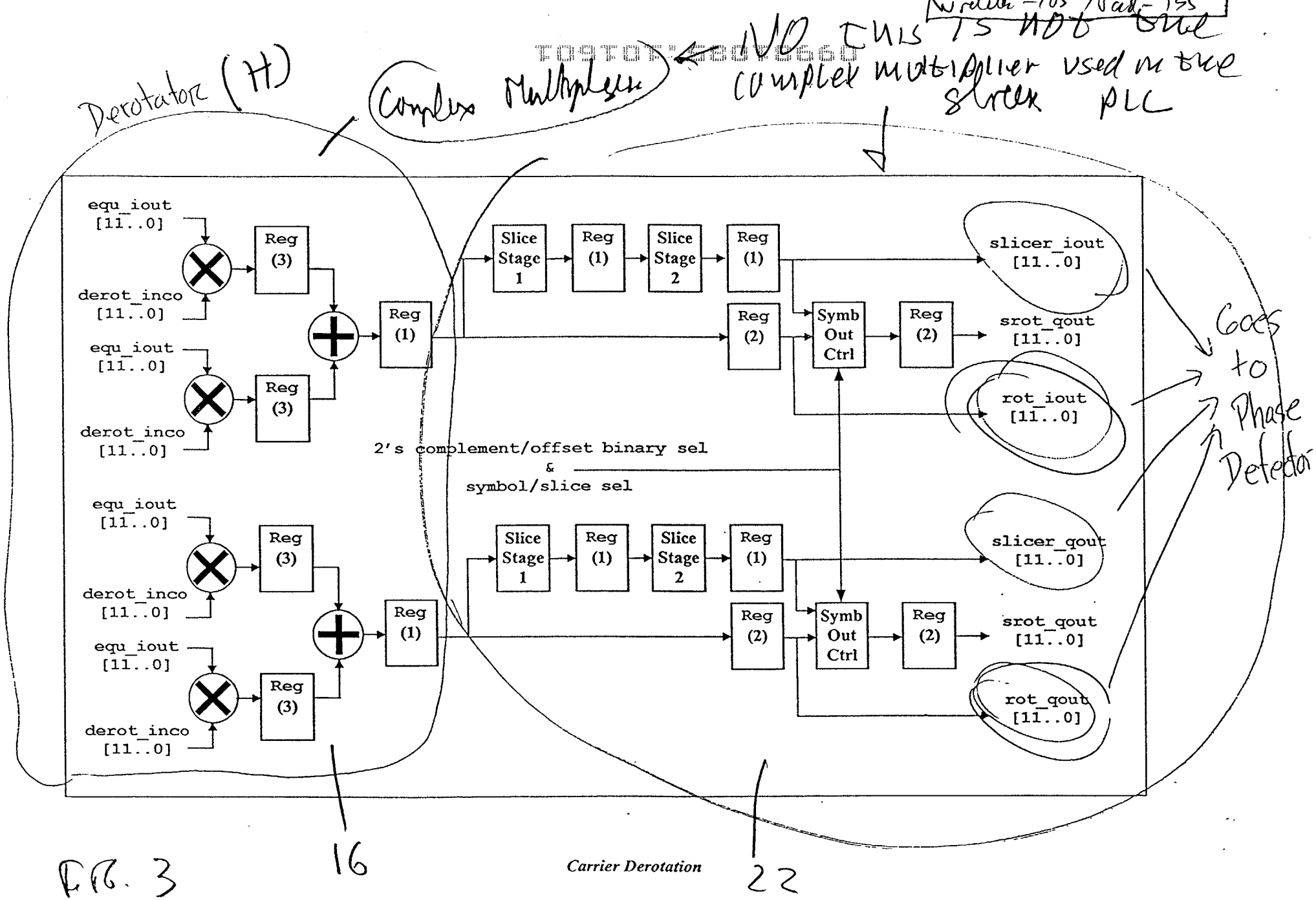

Derotator (H)
Complex Multiplier
NO THIS IS NOT ONE complex multiplier used in the slicer PLC
equ_iout [11..0]
derot_inco [11..0]
Reg (3)
Reg (1)
Slice Stage 1
Slice Stage 2
Reg (2)
Symb Out Ctrl
slicer_iout [11..0]
srot_qout [11..0]
rot_iout [11..0]
slicer_qout [11..0]
rot_qout [11..0]
2's complement/offset binary sel
&
symbol/slice sel
Goes to Phase Detector
16
22
Carrier Derotation

FIG. 3

Modified -165/ Path -195

conjugate

Complex Multiplier missing (E)

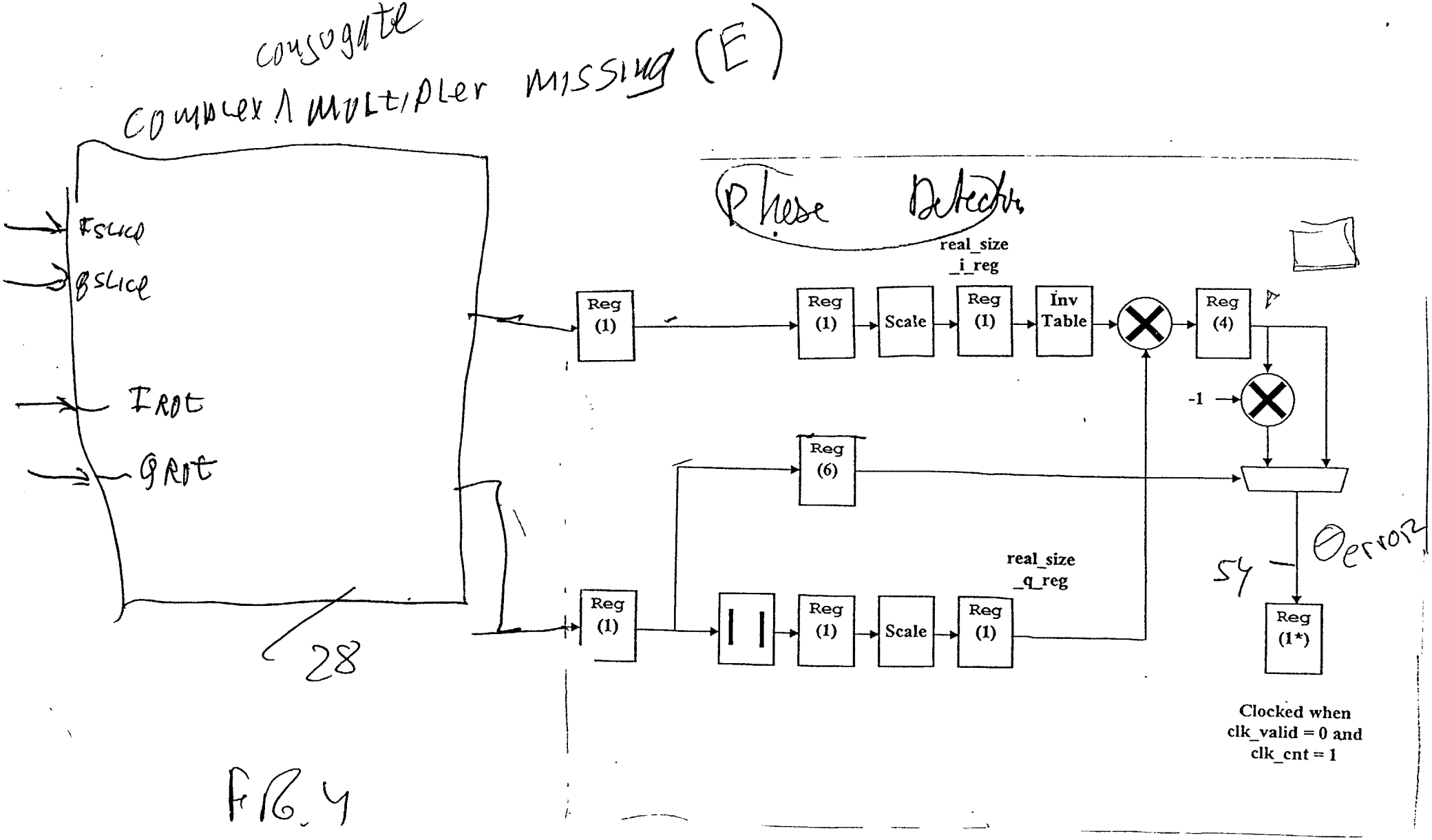


FIG. 4

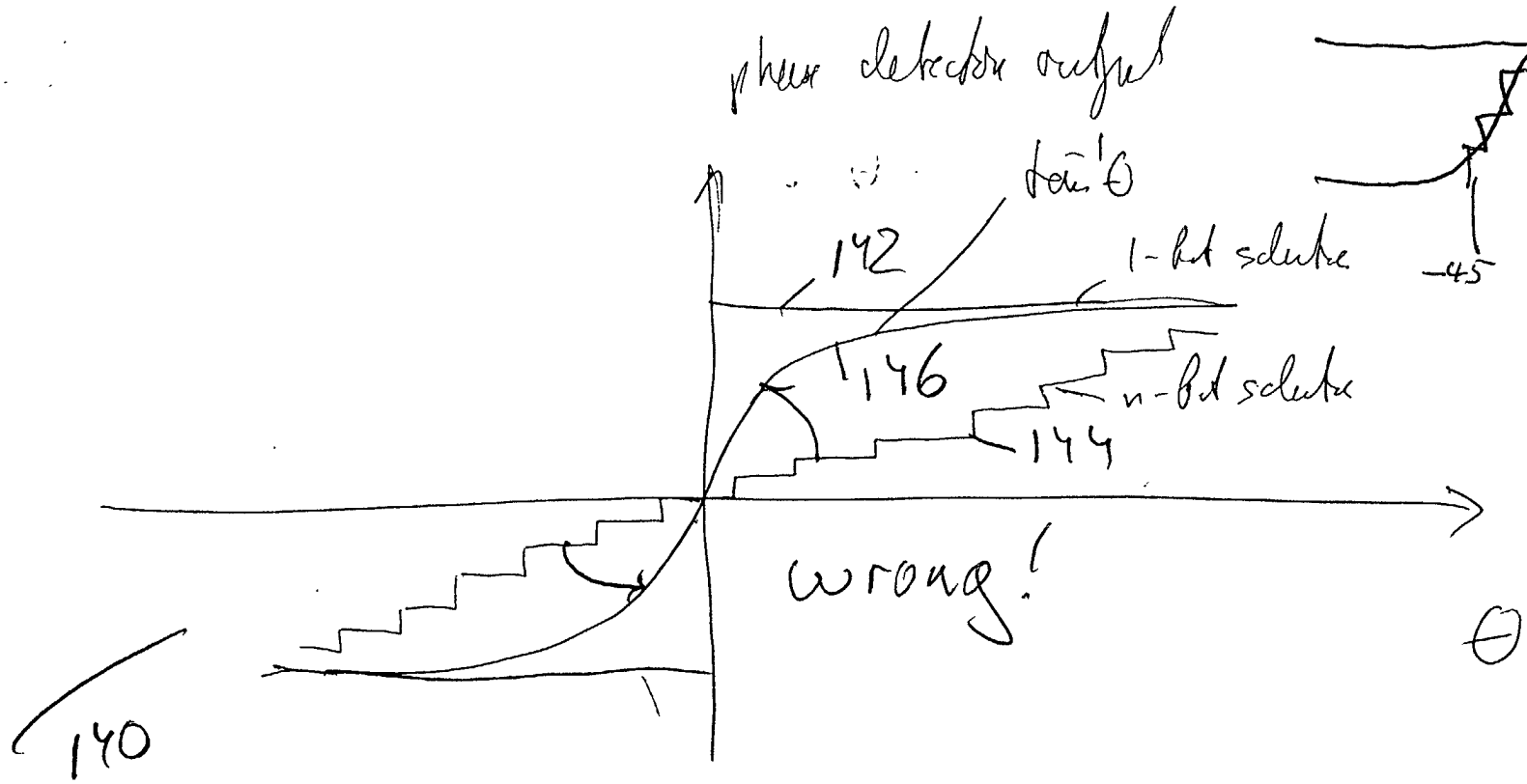


FIG. 5A

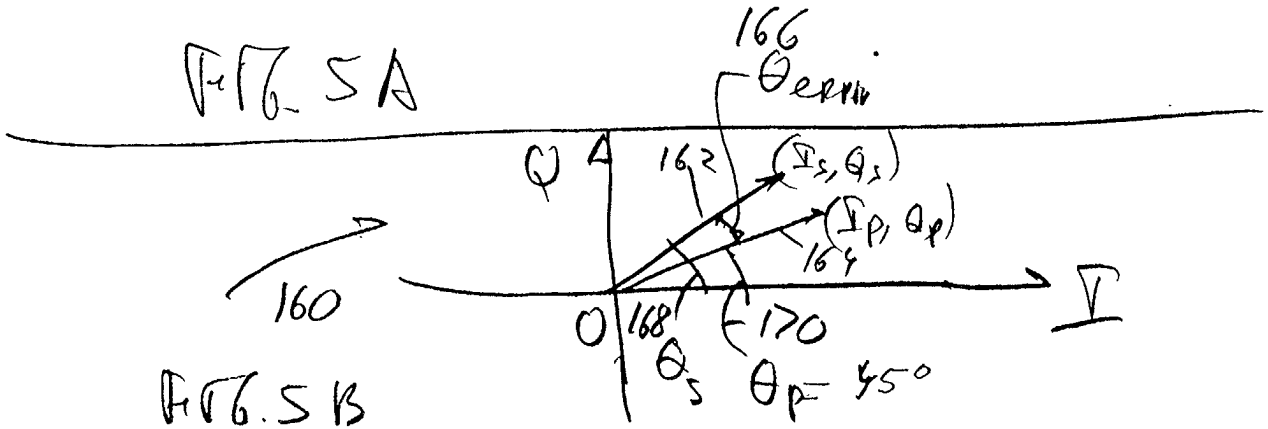
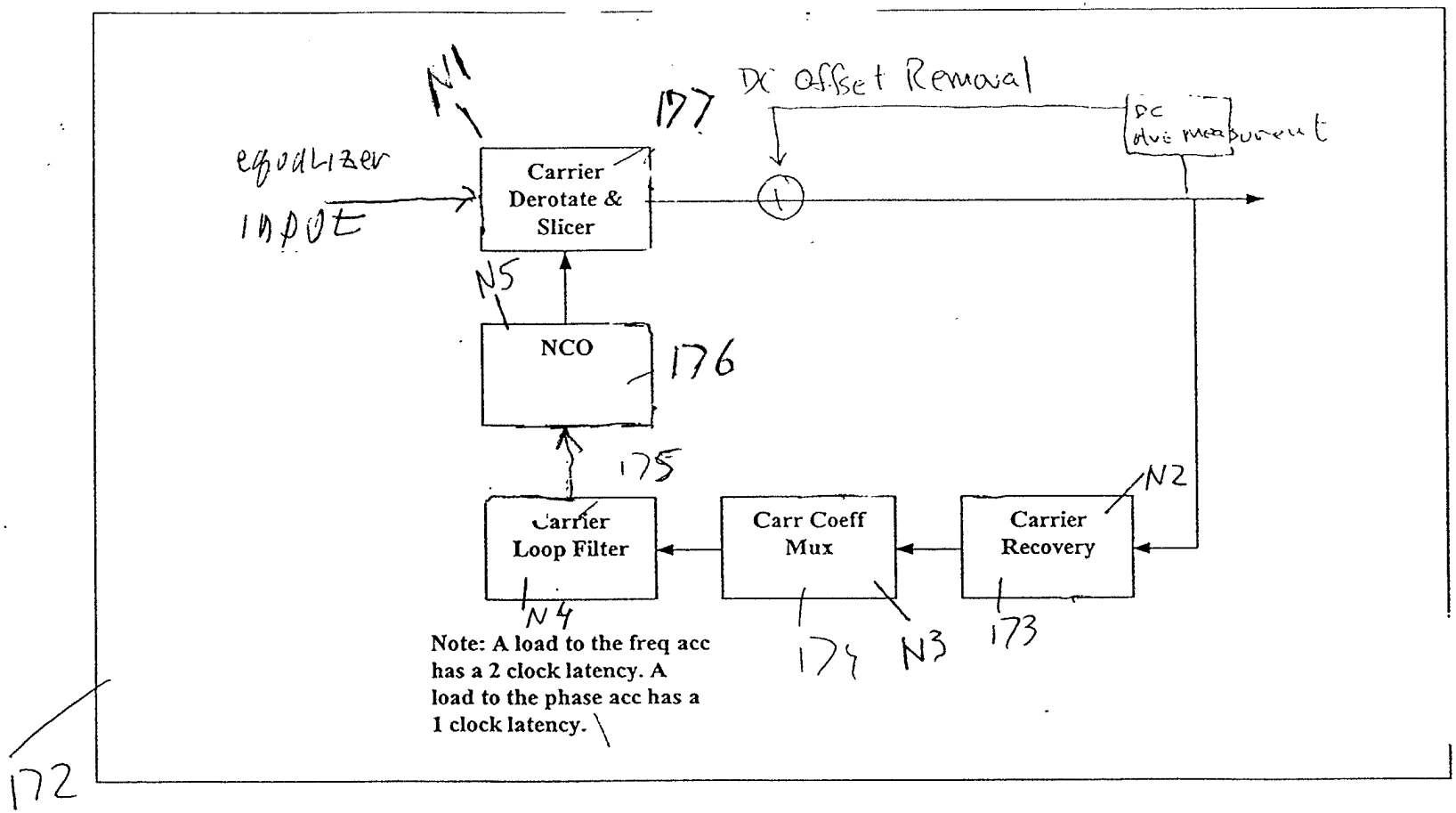


FIG. 5B



Total Loop Latency

FIG 5C

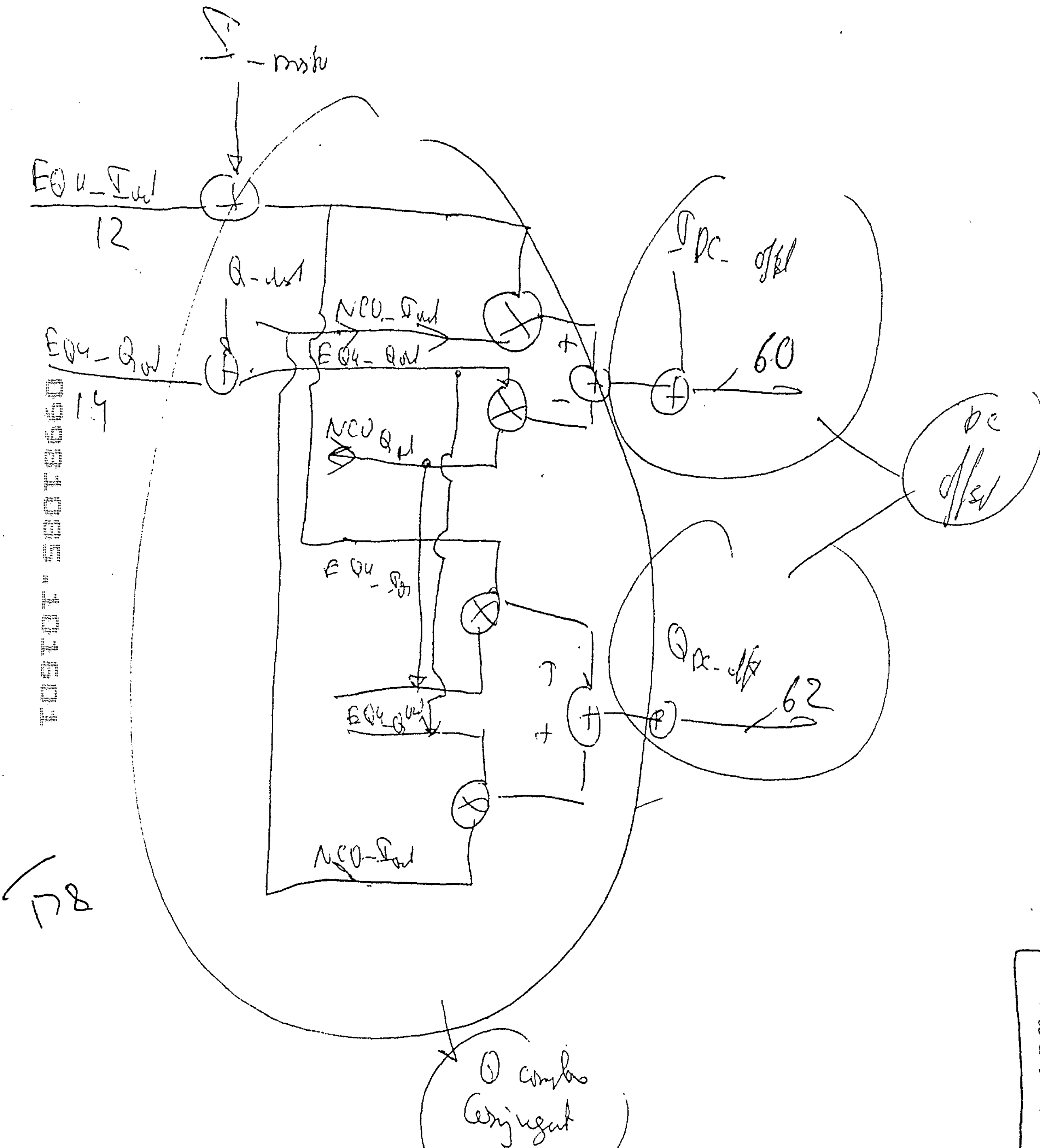
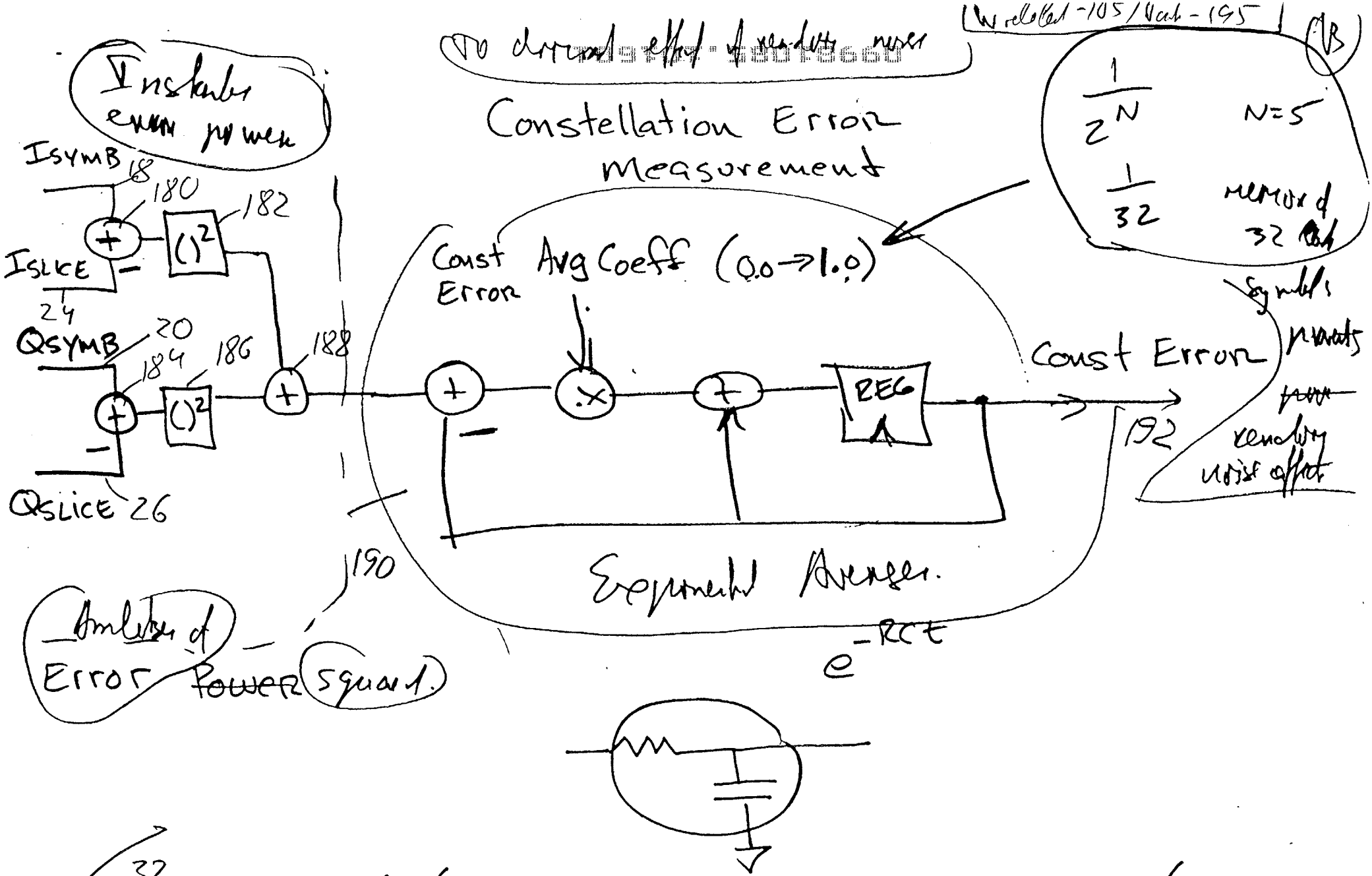


FIG 6A



32

if (AVG COEFF = 0) OUTPUT IS HELD (INPUT IGNORE
if (AVG COEFF = 1) OUTPUT = INPUT
else OUTPUT IS EXPONENTIALLY AVG OF INPUTS

FIG. 6B

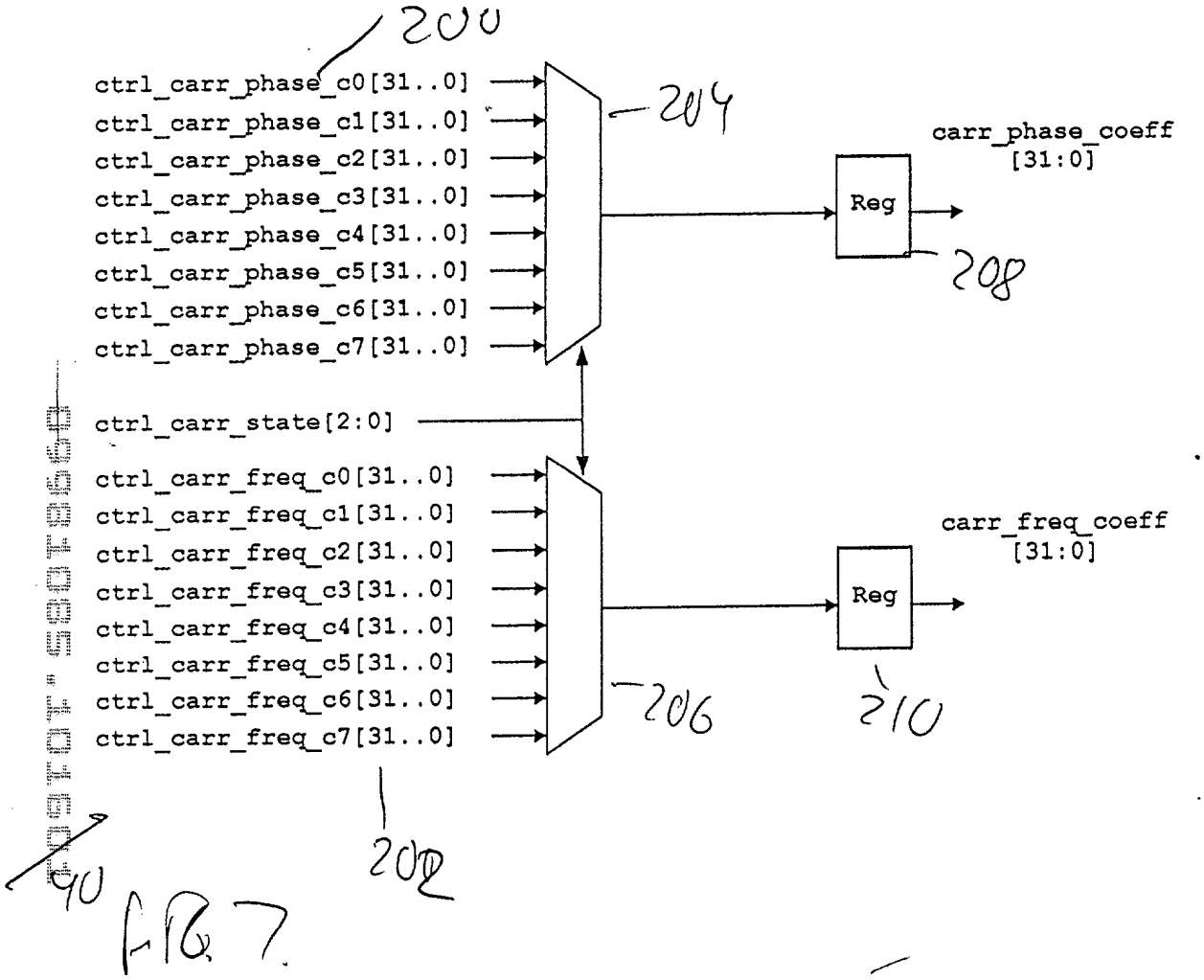
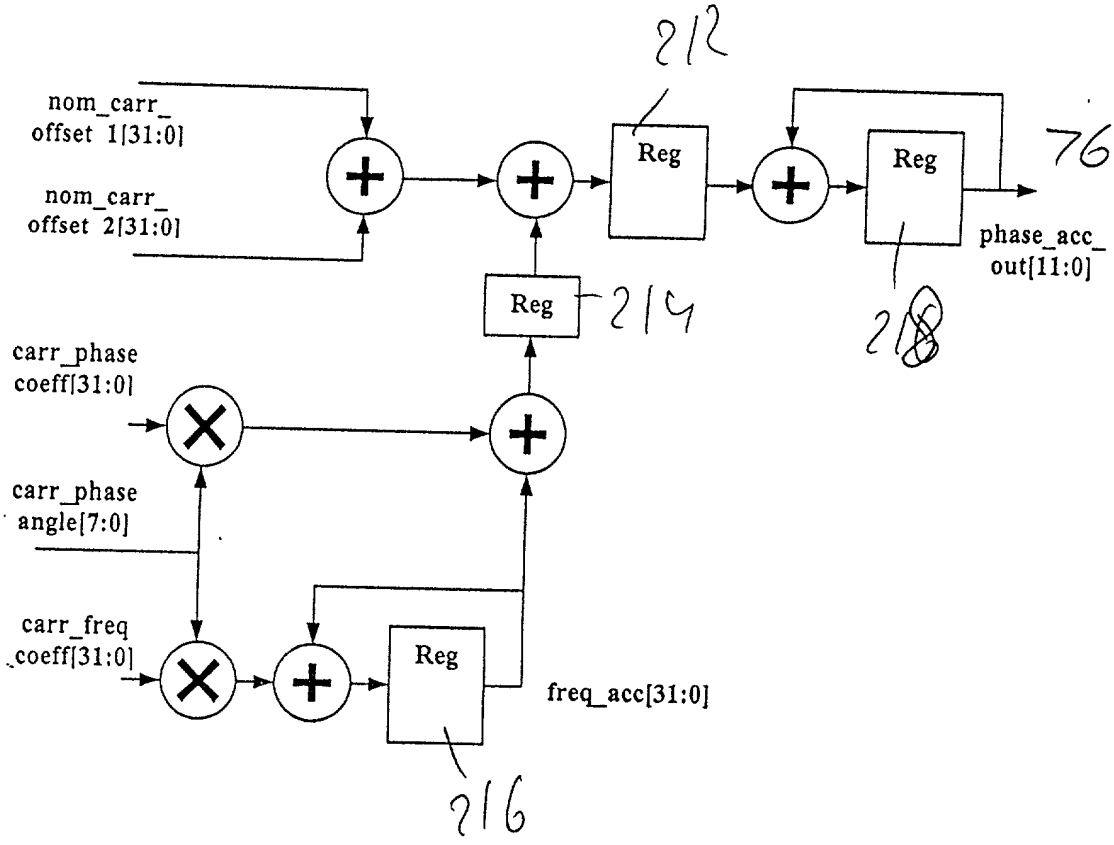
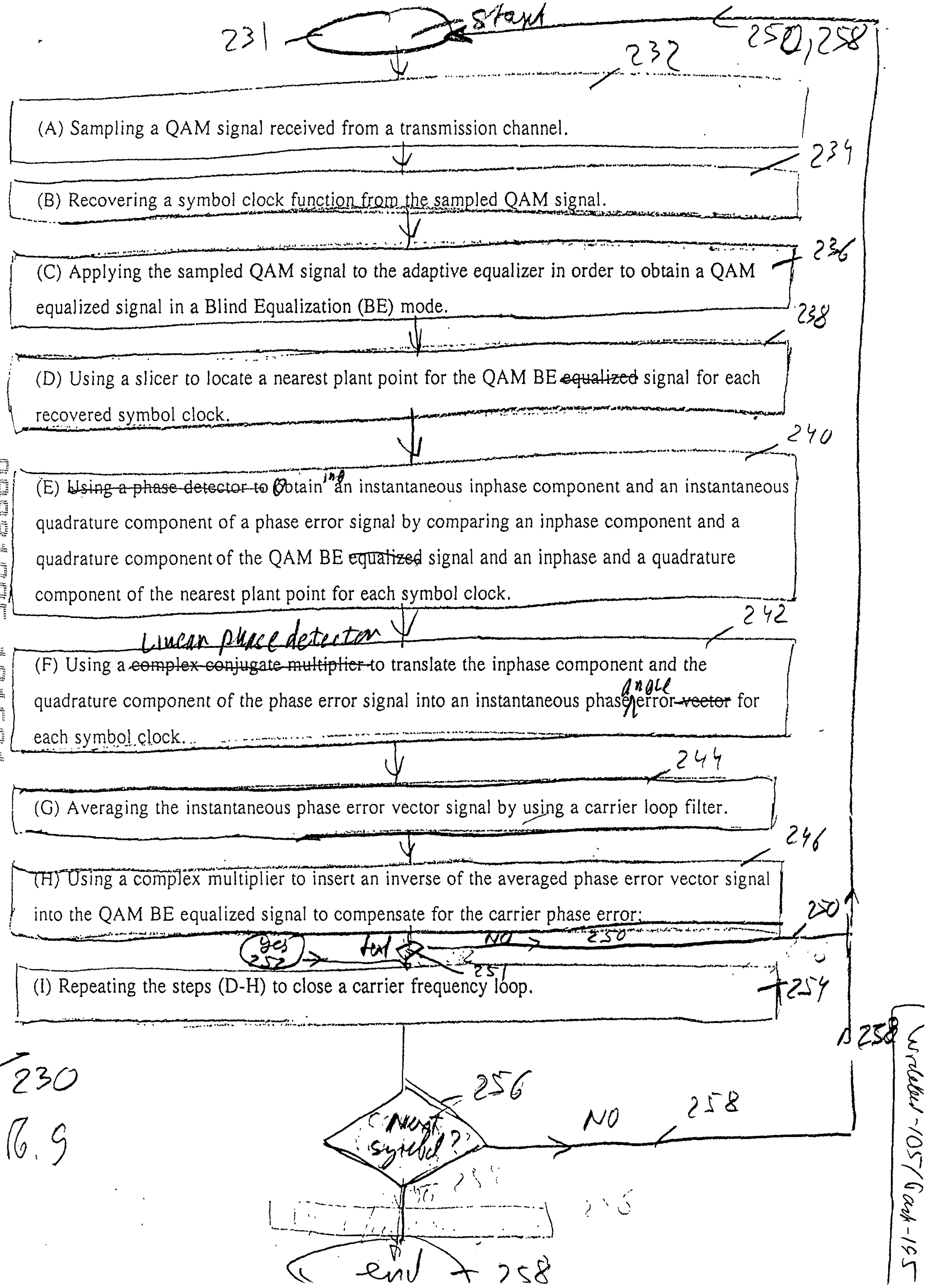


FIG. 7



74

FIG 8. Carrier Loop Filter


Start
231
232
250, 258
(A) Sampling a QAM signal received from a transmission channel.
234
(B) Recovering a symbol clock function from the sampled QAM signal.
236
(C) Applying the sampled QAM signal to the adaptive equalizer in order to obtain a QAM equalized signal in a Blind Equalization (BE) mode.
238
(D) Using a slicer to locate a nearest plant point for the QAM BE ~~equalized~~ signal for each recovered symbol clock.
240
(E) ~~Using a phase detector to~~ Obtaining an instantaneous inphase component and an instantaneous quadrature component of a phase error signal by comparing an inphase component and a quadrature component of the QAM BE ~~equalized~~ signal and an inphase and a quadrature component of the nearest plant point for each symbol clock.
242
(F) Using a ~~complex conjugate multiplier~~ Linear phase detector to translate the inphase component and the quadrature component of the phase error signal into an instantaneous phase angle error ~~vector~~ for each symbol clock.
244
(G) Averaging the instantaneous phase error vector signal by using a carrier loop filter.
246
(H) Using a complex multiplier to insert an inverse of the averaged phase error vector signal into the QAM BE equalized signal to compensate for the carrier phase error.
250
yes 252
test
NO
250
251
(I) Repeating the steps (D-H) to close a carrier frequency loop.
254
258
256
Next symbol?
NO
258
end
258

230

FIG. 9

Selecting an initial set of PID coefficients by using the state machine to set the variable bandwidth of the carrier loop filter to be higher than a frequency uncertainty during a QAM signal acquisition state of the QAM demodulator. 262

↓

Adjusting the initially selected set of PID coefficients by using the state machine in order to decrease the initially set bandwidth of the carrier loop filter in incremental stages to be less than the frequency uncertainty during a carrier tracking state of the QAM demodulator. 264

244

Step 6. – Normal Mode

FIG. 10

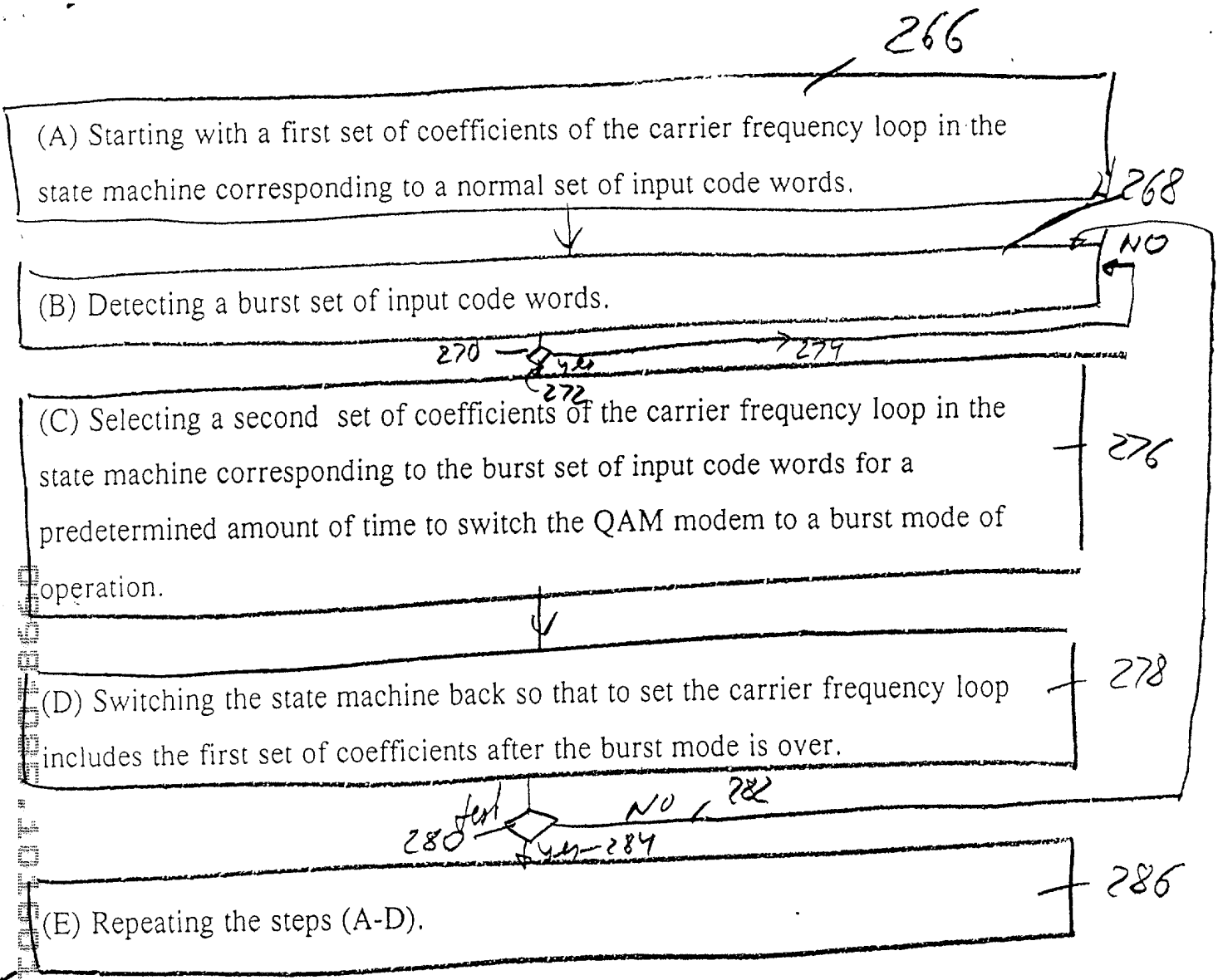

266
(A) Starting with a first set of coefficients of the carrier frequency loop in the state machine corresponding to a normal set of input code words.
268
NO
(B) Detecting a burst set of input code words.
270
272
274
(C) Selecting a second set of coefficients of the carrier frequency loop in the state machine corresponding to the burst set of input code words for a predetermined amount of time to switch the QAM modem to a burst mode of operation.
276
(D) Switching the state machine back so that to set the carrier frequency loop includes the first set of coefficients after the burst mode is over.
278
test
NO
282
280
284
(E) Repeating the steps (A-D).
286
244
Step 6 – Burst Mode

FIG. 11